of comet *b* 1881, Dr. Janssen finds that the intensity decreased in a ratio between the fourth and sixth power of the distance from the nucleus.

ATMOSPHERIC DISPERSION.—The fact that the image of a star as seen in a telescope is drawn out into a short vertical spectrum, with the red end uppermost, was noticed as long ago as 1729 by Bouguer, and the effect of the difference in colours of stars upon refraction appears to have been indicated in a general way by Lee in 1815. Even in small instruments this atmospheric spectrum is very noticeable in the case of bright stars at low altitudes, but, if necessary, it can be corrected by means of a thin prism placed in front of the eyepiece, or by employing an eyepiece of the form devised by the late Sir George Airy. In a recent paper (*Monthly Notices R.A.S.*, January), Dr. Rambaut points out the importance, in these days of extreme accuracy, of introducing a correction for atmospheric dispersion—according to the varying colours of stars—more especially in connection with observations of two stars in close proximity, as in measures of double stars, and observations for parallax. The claims of this hitherto rather neglected factor appear to be fully substantiated by a series of measures at different hour angles of β Cygni, in which double star the colours of the components are strongly contrasted; they "show clearly a systematic difference affecting the distance between them, of the sort, and in the direction, that theoretical considerations indicate." Dr. Rambaut also shows that the systematic differences depending upon hour angle in the measures for the parallax of α Centauri by Drs. Gill and Elkin, which they corrected by empirical formulæ, are due to a difference in the mean refrangibility of the light of the star and of the comparison stars. Further confirmation is derived from a re-discussion of the Dunsink observations on the parallax of 61 Cygni, and the resulting value is corrected from $0''.465$ to $0''.400$.

An ingenious method of measuring atmospheric dispersion has been devised by M. Prosper Henry, and values determined for different colours (NATURE, vol. xliii. p. 400).

THE SUN'S PLACE IN NATURE.[1]

I.

I AM anxious to give in these lectures a statement, as clearly and as judicially as I can, of the discussions which have been going on since these results were published, to show what holes have been picked in the new views, and what new truths may be gathered from the new work which has now been brought to bear upon the old, so that as a result the place I have given to the sun among its fellow stars may be justified or withdrawn. These lectures will be different from the former ones, inasmuch as I then attempted to give you a piece of quiet history of several regions of fact and knowledge which had been well surveyed and mapped, and had become part and parcel of the common property of mankind. But now I shall have, in considering the discussion, rather to take you with me into the forefront of those who are fighting the battles on the confines of the unknown. I have to bring you news from the front, something like that which we are promised to-morrow or the next day from Port Arthur. I have to show how the battle is waging, who has lost, what positions have been occupied, and what things new and true and beautiful have been wrested from the unknown region; and I am the more anxious to do that because it enables me to bring before you the enormous advantages under which such work is now carried on; advantages in that now, when any question is put to any part of the heavens, we know that there are many good workers employed under the best possible conditions to get the particular information that we want; besides these advantages, in every branch of inquiry we find advances gigantic, marvellous, almost beyond belief.

I am sorry to say that in this work the centre of gravity of the activity has left our country and has gone out West. We have to look to our American cousins for a great deal that we want to know in these matters, for the reason that now they not only have the biggest telescopes, and most skilled observers, but also they have been wiser than we—they have occupied high points on the earth's surface, and thus got rid of the atmospheric difficulties under which we suffer in England, and especially in London.

Let me bring before you one of the most perfect pieces of workmanship in the world constructed to investigate the phenomena of the heavens. It is a photograph of the Lick Observatory, situated at an elevation of 4000 feet on Mount Hamilton. Mr. Lick, the founder, was a very ambitious man. He was, I believe, an hotel-keeper at San Francisco, but however that may be, he has made his name immortal by helping on the progress of mankind. I wish we had some hotels like the San Francisco hotel in this country, and some Mr. Licks, because then some Englishman might immortalise himself in the same way. This, then, is the magnificent locality in which a great deal of the work that I shall have to refer to has been done. The principal instrument of this great Observatory is a refracting telescope having an object-glass three feet in diameter, and a tube fifty-four feet in length. This is practically the most important telescope in the world at the present moment, and to give you an idea of the wonderfully

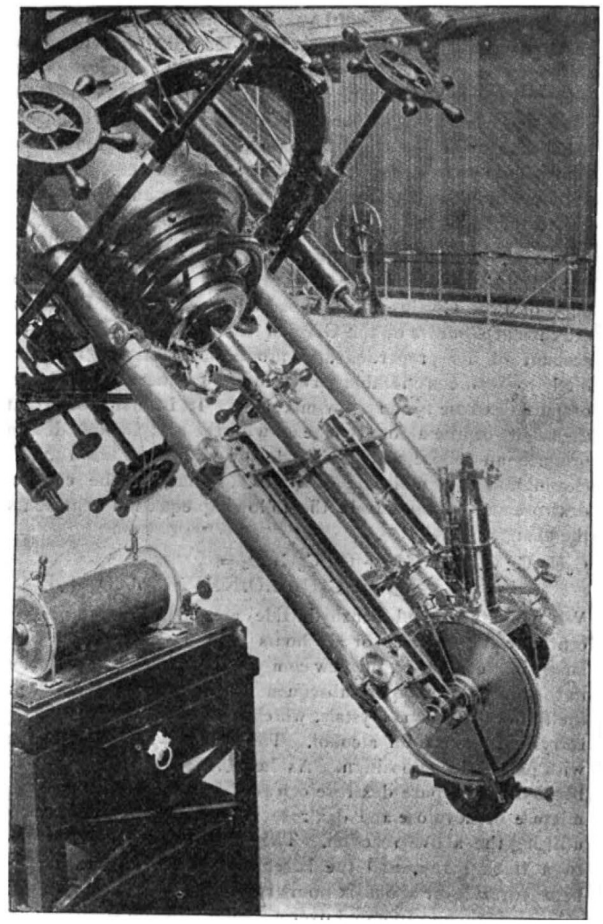

FIG. 4.—Spectroscope attached to the eye-end of the Lick Telescope.

broad way in which the authorities have gone to work, I need only state the following fact. Some of you who have been in an observatory may remember that it has sometimes been very difficult to get the observatory chair at the right height, or in the right position, for observing a star or any celestial body with any comfort. The Americans get over this by simply raising the floor. By means of hydraulics the enormous floor, some 80 feet in diameter, is moved up and down with the chair. The importance of spectroscopic work has not been lost sight of in the equipment of the Observatory, and a very powerful spectroscope can be used in conjunction with the great equatorial for observing or photographing the spectra of the various celestial bodies (Fig. 4).

One of the most important telescopes in England at present is Dr. Roberts' reflector, with which several majestic represen-

[1] Revised from shorthand notes of a course of lectures to working men at the Museum of Practical Geology during November and December, 1894. (Continued from page 377.)

tations of the heavenly bodies have been produced; these I shall have to show you at one time or another in relation to different branches of our subject. In this instrument (Fig. 5) a reflecting telescope of 20 inches aperture is combined with a refractor of 7 inches aperture. The refractor is used as a guiding telescope, and ensures that the images of the stars and nebulæ fall on the same part of the photographic plate which is being exposed in the reflecting telescope throughout the whole

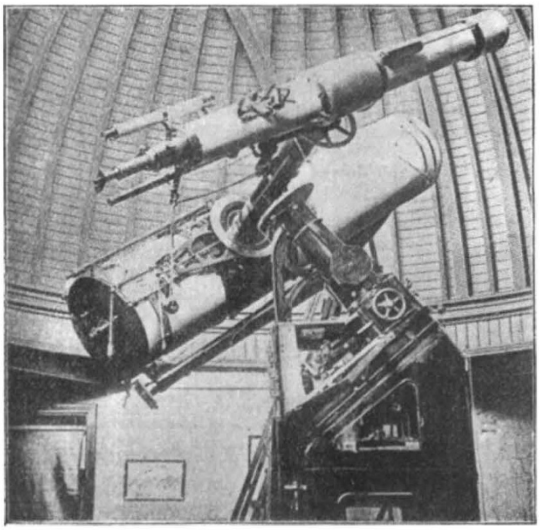

FIG. 5.—Dr. Roberts' twin telescope.

time of the exposure. Even with the best driving clocks, such a guiding telescope cannot be dispensed with when the exposures are prolonged for the number of hours necessary in some cases.

First for the nebulæ. What is the difference, written down in this way, between a nebula and a star cluster? A comparison of Figs. 6 and 7 will at once show that in the case of a star cluster we have to deal with a collection of separate stars, while in the case of a nebula there is a filmy sort of

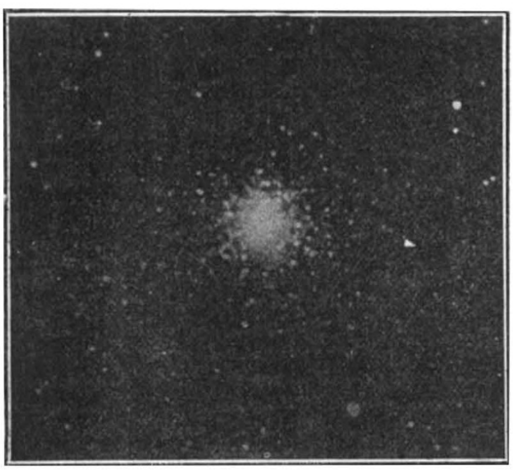

FIG. 6.—The Cluster 15 M Libræ, from a photograph by Dr. Roberts.

luminosity which is quite distinct from the neighbouring stars. Here and there the nebulosity is suddenly brightened, but, as I shall show hereafter, these condensations are not to be regarded as stars in the ordinary sense. Here is the nebula of Orion, which we owe to that wonderful telescope of Dr. Roberts. Several of you may have seen the nebula of Orion with a telescope, but you have never seen it exactly like this. You get here the idea which gave rise to the old notion of a candle shining through horn; this nebula is the one which, on account of its brightness, spectroscopically gives us most easily indications of those bright lines which for ever set at rest the idea that we are dealing with solid or liquid bodies.

At the beginning of the present century it was found that in

FIG. 7.—The spiral nebula in Canes Venatici, from a photograph by Dr. Roberts.

order to get the spectra of stars the best thing to do was to put a prism outside the telescope, and to let the light enter the telescope and be brought to a focus after it had passed through the prism; and it is a most unfortunate thing, that the

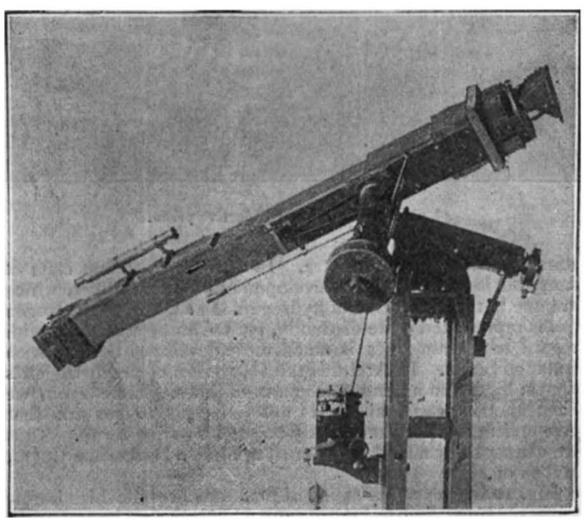

FIG. 8.—Showing method of photographing stellar spectra by the objective prism.

neglect of the application of this principle has landed us probably in a delay of fifteen or twenty years in gathering knowledge on this subject. The whole credit of reviving this idea is due to Prof. Pickering, of the Harvard College, who since its application has been able, with the aid of the large funds that he has at his disposal, and the magnificent help which he has accumulated round him, to obtain practically the spectra of all the stars down to the fifth or sixth magnitude in both hemispheres. In a few years' time we shall be able to work on the spectra of all the stars in both hemispheres, just as well as we can at present deal with their magnitudes and positions by the star charts.

An instrument of this kind (Figs. 8 and 9), having an aperture of only 6 inches, has been in use at Kensington for some time, and some of the results which have been obtained by its aid are shown in Figs. 3, 10, and 11. They are absolutely untouched photographs.

Without going into minute differences, we can, and, if we are wise, we shall deal first of all with the larger differences presented by the various classes of stars which people space. Here we have photographs of stars of different classes (Fig. 3). You will understand from these photographs how perfectly justified Rutherfurd and others have been in attempting to classify the stars by means of their spectra. In Sirius we get one class of stars, distinguished by the development of certain lines, which are due to the absorption of hydrogen. In α Cygni the hydrogen gas is represented quite distinctly, but the absorption there with regard to certain lines is much more developed than in such a star as Sirius. In Arcturus the absorption of the hydrogen is almost hidden in an enormous mass of lines. Here again we have another class, and it is not too early to remark that Arcturus in its spectrum exactly resembles our own sun. Thus we can say the sun is like Arcturus, not like α Herculis, α Cygni, and so on.

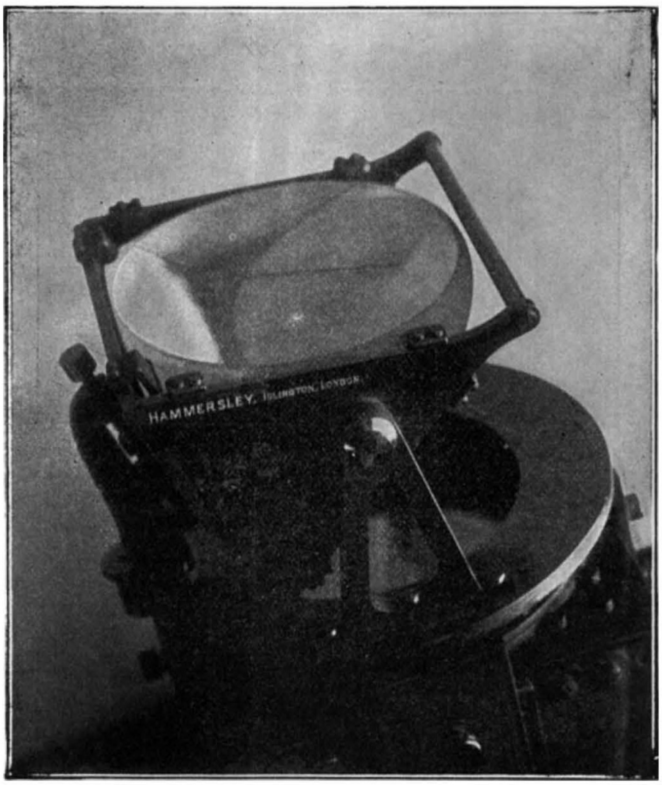

FIG. 9.—Details of objective prism.

Fig. 10 is an exemplification of the kind of result which is now being obtained, and the kind of work which can now be carried on with regard to the minute structure of these spectra. One is the star Arcturus, and the other a star in the constellation of the Swan. You see at once that, if it is a question of attempting to determine whether stars are like each other, or whether they are unlike each other, and the points in which they differ, with the resources of modern science at the present moment—small

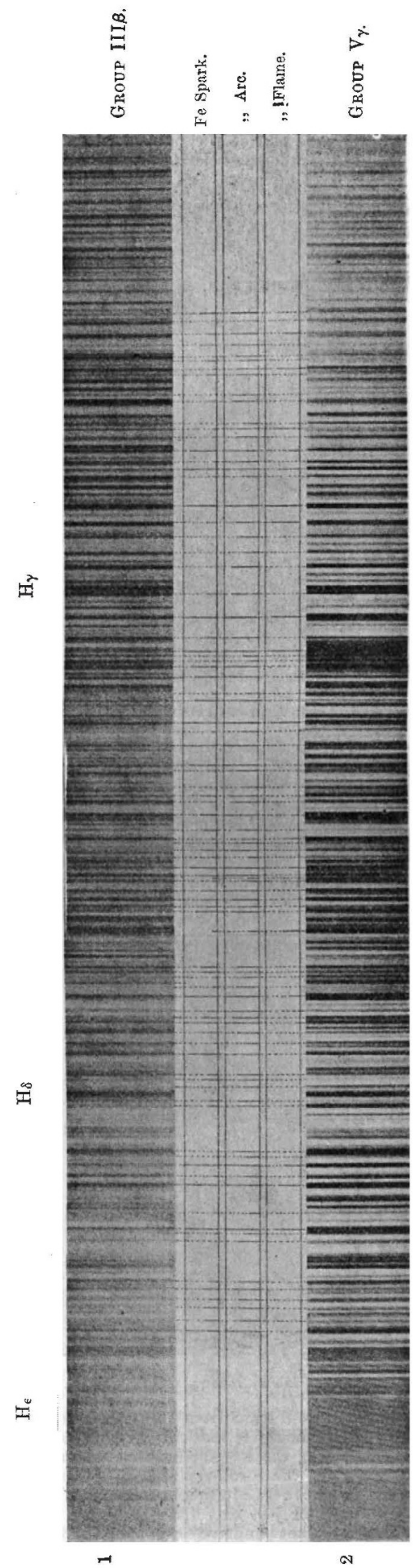

FIG. 10.—Spectrum of γ Cygni (1) compared with that of Arcturus (2). From photographs taken at Kensington.

as those resources are in some instances—we have really an opportunity of doing a considerable amount of work. The particular bit of work which is represented in this diagram is an inquiry showing how the iron lines observed in the spectra are represented in these different stars; we can see whether the condition of the iron vapour is the same in a star like Arcturus as it is in a star like γ Cygni. You will see that from this point of view there is a great difference in the atmospheres of these two stars.

The definition of the negatives obtained by means of the objective prism is of such excellence that they may be almost indefinitely enlarged, and this gives them a special value when we come to investigate the smaller differences between stars which have more or less resemblance to each other. Practically, we are able to dispense with elaborate micrometric measurements, and by placing the enlargements alongside each other, to see at a glance which lines agree in position and which are different.

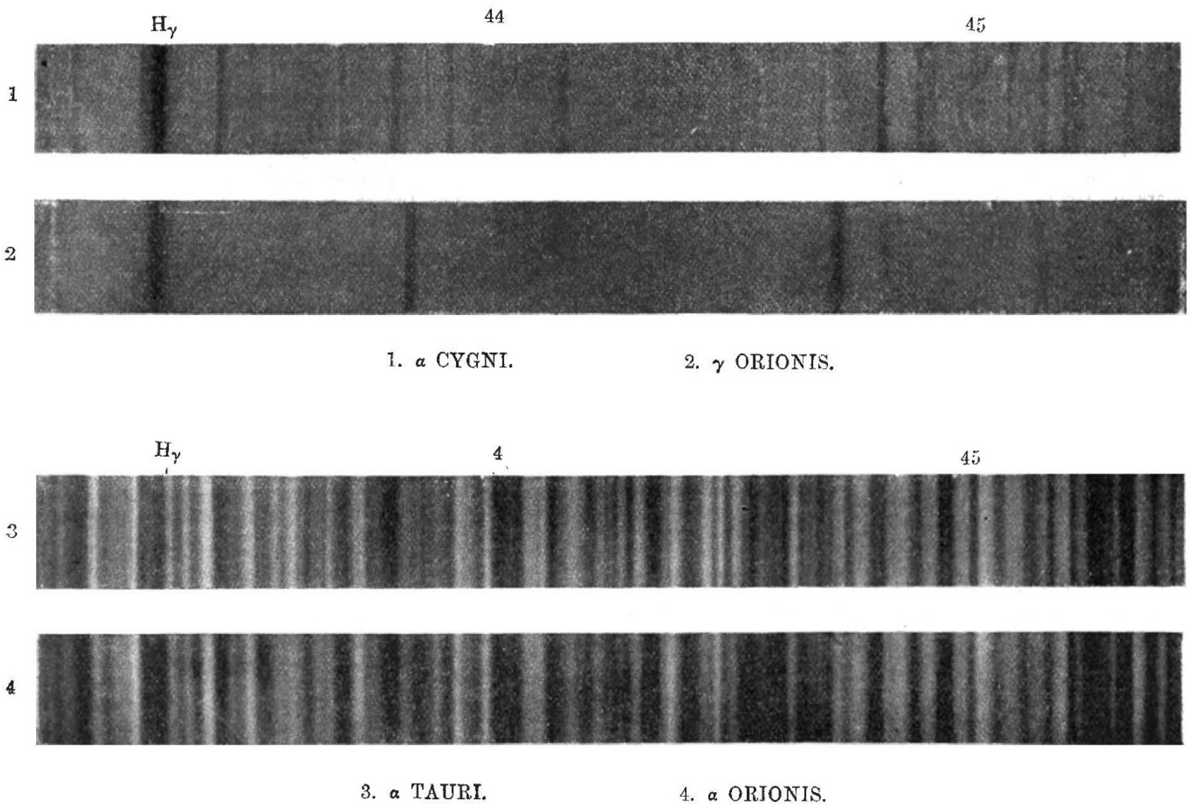

FIG. 11.—Portions of stellar spectra, greatly enlarged.

The spectra represented in Fig. 11 have been enlarged twelve times from the original negatives, and on this scale the whole of the visible spectrum would be more than a yard in length. Here we observe, in the first place, the immense difference between two groups of stars, one in which the lines are very numerous, the other in which the number of lines is relatively small. We also have an opportunity of studying the more minute differences between stars like α Tauri and those like α Orionis, and between stars like α Cygni and those like γ Orionis. In some cases, differences which might easily be overlooked altogether in an examination of the negatives alone, become apparent when the scale is enlarged in this way.

Thus, by means of the aids which have been placed at our disposal, by the recent improved condition of our stock in trade, and the wonderful diligence and skill of observers, chiefly in America, who have taken up the new work, we are now in a very much better position than we have ever been before to investigate this subject.

J. NORMAN LOCKYER.

(*To be continued.*)

NATHANAEL PRINGSHEIM.

BOTANISTS throughout the world will have heard, with deep regret, of the death of Prof. Pringsheim on October 6, of last year. His name is inseparably associated with the modern progress of the science, and there must be many, who, like the writer of this notice, can trace their first interest in scientific botany, in no small degree, to the fascination of Pringsheim's discoveries. Pringsheim was born in Silesia, in 1823. His career, though an active one, was unusually free from official cares. Except during four years, when he was Professor at Jena, he does not appear to have held any teaching post of importance. During the greater part of his scientific life, his work was carried on in a private laboratory, founded by himself at Berlin, and devoted entirely to the researches of original workers.

Pringsheim was founder and editor, from 1858 to the time of his death, of the famous *Jahrbücher für Wissenschaftliche Botanik*, and was President of the German Botanical Society from its first origin. He was among the many distinguished foreign men of science who attended the meeting of the British Association at Manchester, in 1887.

The scientific activity of Pringsheim extended over a period of fully forty years (1848–1888), a time which covers what was perhaps the most brilliant epoch in the history of botany. His work began in the days when the science of histology was being built up on the basis of the cell-theory of Schleiden and Schwann; he himself contributed essentially to its construction. Pringsheim's greatest services to science, however, were in the department of the morphology and life-history of the lower plants, a line of research in which he was unsurpassed. Comparatively late in life his attention became directed to physiology, but in this direction his success was less conspicuous.

Pringsheim's earliest contribution to science was his Latin dissertation, "De formâ et incremento stratorum crassiorum in plantarum cellulâ" (Linnæa, 1848), in which he discusses a question much agitated at that time, whether the